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## COLLEGIATE MATHEMATICS FOR WAR SERVICE.

The chief aim of this department will be to gather and publish information concerning mathematical courses in preparation for war service. The editor invites the contribution of suitable articles and notes, and hopes, since timeliness will be important, that appropriate material will be sent in as soon as it becomes available. If an article is such that the Editors of the MONTHLY deem its early publication sufficiently pressing, preprints of it will be prepared. The editor of this department will also undertake to furnish to the extent of his means material and information desired by individual readers. Address Dr. Henry Blumberg, University of Illinois, Urbana, Ill.

COURSES IN COLLEGE IN PREPARATION FOR THE NAVY.<sup>1</sup>

By R. G. D. RICHARDSON, Brown University.

**The Need.** To the colleges no call of the country in its war program is more urgent than that of the navy for commissioned officers. Besides the need of line officers for the new ships of the navy proper, the department has announced that it needs 22,000 commissioned officers to man the new mercantile marine which the navy will operate. Very few enlisted men have the education necessary to qualify for anything beyond the rank of petty officer. The Naval Academy can graduate at most a few hundreds yearly. The many auxiliary schools are filled beyond capacity but are turning out only a fraction of the number required. While a minimum of three to six months' sea experience has been a prerequisite, a large part of the theoretical training for candidates for the ensign's commission has in many instances been given in academic institutions. Since all candidates for commission as ensign must have the preliminary education required for admission to college, it is natural that the navy should look to us in increasing measure to supplement the efforts of the other agencies by giving courses which will aid in preparing men for this examination.

All college men who are physically fit must look forward to being called by their country to some arm of the service, and every college recognizes the imperative necessity of giving its students some technical preparation. Many men will prefer the navy to other branches of the service, and it devolves upon each school to ascertain how it can give the elements of the necessary training by adapting its present courses or adding new ones. This will in part anticipate any action which the government may deem it wise to take in directing the instruction in mathematics in those colleges whose students are furloughed for instruction.

**What is Already Being Done.** The experiences of other institutions furnish

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<sup>1</sup> This brief sketch has been prepared very hastily and is subject to charges of inadequateness and inaccuracy. Its only excuse is that it may serve to call attention to the needs before definite programs for the academic year are made up. R. G. D. Richardson, Chicago, August 29 1918.

a basis for judgment as to what may be accomplished. Various types of work are already under way of which some examples may be cited.

Several institutions such as Harvard and Pennsylvania have loaned to the government their facilities for instruction and housing. Enlisted men who have the necessary basis of education and are deemed to possess the requisite personal qualifications are given training by officers of the navy to fit them for an ensign's commission or for the radio service.

In another group are institutions such as Yale, Princeton, Brown and the Universities of Michigan, California, and Washington which have regularly organized Naval Units. The formation of such Units is encouraged by the Navy Department but in most instances no official recognition has as yet been given. The units differ widely in the work they are attempting. While some students in a few engineering schools are being trained for the engineering branch, the greater number are headed for commissions in the line. In some cases a retired officer is assigned to service as head of the Unit and petty officers detailed to take charge of the drills. The greater part of the theoretical instruction, however, is given by members of the regular faculty. Candidates for commissions in the line take courses in Navigation, Seamanship, Navy Regulations, Ordnance, and Gunnery. Among the drills are day and night signalling of all kinds, handling of boats under oars and sail, School of the Company, Manual of Arms, School of the Section and Battery in Artillery, and Battleship Drills. Men who have enrolled in the Naval Reserve are given opportunity for practical work by means of week-end cruises or summer service on battleships or converted yachts.

Besides these two types of instruction, many institutions are adapting present courses or are introducing new ones with a view to giving preliminary training for future officers. Others are coöperating with outside agencies by furnishing mathematical instruction. The University of California supplements courses given to its undergraduates by courses in extension covering part of the same field as the naval units. During the present summer members of the Faculty of the University of Chicago and Northwestern University have been giving courses for those men, enlisted in the mercantile branch of the service, who have not yet been called to the school at Municipal Pier, Chicago. The Commandant of the station has detailed petty officers to supplement by drills the theoretical instruction in mathematics and astronomy.

**Navigation.** There seems to be no reason why a course in Navigation should not constitute a part of the mathematical program of every institution. Not only is the present demand very urgent but the new merchant marine will continue to call for officers in large numbers after the present war is won.

Prerequisite to such work is a course in Trigonometry with special emphasis on the derivation of those formulas used in computation and on the computation itself. The first topic to be discussed is the determination of position by Dead Reckoning including the methods of Plane, Mid-latitude and Mercator's Sailings. Double interpolation must be taught in connection with the Traverse Tables to be used in these computations. As a preliminary to

the study of the nautical astronomy involved, the student should possess a knowledge of the elements of spherical geometry and spherical trigonometry.<sup>1</sup> Of the latter the essentials include the formulas for right and quadrantal triangles and the Laws of Sines and Cosines together with the modifications of the latter used in calculating the haversine of a side or the haversine of an angle. [hav  $x \equiv \frac{1}{2}$  versin  $x \equiv \frac{1}{2}(1 - \cos x)$ .] An introduction to some of the fundamental notions of astronomy is also necessary at this point.

Since from the standpoint of the student the most difficult ideas are those grouped about the notion of time considerable emphasis should be laid on this topic. One of the most important problems is the complete determination of the position at sea from altitude observations of celestial bodies. This is best accomplished by finding the intersection of two Sumner lines. A Sumner line or line of position is a small circle on the earth from any point of which the observed body will have the same altitude at the same instant. The center of the circle will be the point which has the observed body in its zenith. Perhaps the simplest application of nautical astronomy is the determination of latitude from a meridian altitude by means of the various corrections. For a meridian altitude the Sumner line will then be tangent to the parallel of latitude, and for a prime vertical observation, it will be tangent to the meridian. The most favored scheme for the reduction of the Sumner line observations is that of St. Hilaire. Out of such a computation comes as an almost immediate by-product the azimuth of the observed body. This gives at once the compass error which is another important problem of nautical astronomy.

The standard texts for this course will be cited in the specific instance below. Many books on navigation have been published within the past four years but most of them give rule of thumb methods rather than a mathematical treatment. A standard British text is by Gill (Longmans, Green & Co.) and from the standpoint of college instruction the last edition is very useful. Among other books to be recommended for the instructor are Martin's Navigation (Longmans, Green & Co.), Hall's Navigation (W. B. Clive, London), Muir's Navigation and Compass Deviations (U. S. Naval Institute, Annapolis, Md., \$4.20).

The use of the compass, pelorus, vernier and chronometer and of the sextant with the real or an artificial horizon is necessary and to these may be added other instruments used at sea. It is essential that the student become familiar with the nature of charts of various kinds. Mercator Charts, Great Circle Charts and Position Plotting Sheets can be bought at cost from the Hydrographic Office (a catalog of all the publications of this office may be obtained for 30 c.).

If time is limited, fifty hours in Navigation with twice as much outside preparation on the part of the student will serve as a valuable introduction. In that time the central features can be covered. But it would be preferable to extend the course to ninety hours in order to take up the greater part of the topics covered by Bowditch, to acquire accuracy and facility in computation and

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<sup>1</sup>Spherical Trigonometry is now a prerequisite for the naval school at Pelham Bay, L. I.

in handling the instruments, and to learn the use of the Kelvin-Aquino method for solving oblique-angled triangles by tables. The nature of the standard maintained by the Navy Department can be ascertained in this, as in other subjects, by an examination of the papers set for the ensign commission. Copies may be obtained on application to the Bureau of Navigation, Washington, D. C.

**Other Courses.** Since for the navy the target is generally in view, the problems of Ordnance and Gunnery are quite different from those of the army. From such books as Curtin's *Naval Ordnance*, Alger's *Ground Work of Practical Naval Gunnery* (U. S. Naval Institute, Annapolis, \$4.85, \$4.50) and the Bureau of Ordnance pamphlets the instructor could work up a few lectures on this topic. The elements consist largely in practical applications of arithmetic and trigonometry, and considerable practice in examples is necessary to insure correct understanding of the problems involved and to acquire facility.

The larger part of the training for officers is, of course, non-mathematical. While instructors competent to give extended courses in seamanship are not in general available and while many institutions will not find it practicable to obtain petty officers for the drills, some text-book work could in many cases be given to advantage. Instruction in the reading of charts may be supplemented by Buoy and Light Lists and the Coast Pilot. Charts on large and small scale obtainable from the Coast and Geodetic Survey are useful in laying out courses and in the study of the coast and harbors of some particular locality. Actual inspection of light-houses, buoys, and ships in process of construction would be a valuable auxiliary to instruction from the text. Elementary instruction in practical seamanship may be illustrated by means of models and by practise with small boats under oars and sail. Lectures on marine meteorology are valuable. Beside the *Blue Jackets Manual* (U. S. Naval Institute, 75 c.), which the men should know from cover to cover, students might be given parts of the U. S. Navy Regulations, *Watch Officers Manual* (U. S. Naval Institute, \$1.10) and an elementary text in piloting, buoys, rules of the road, such as Chapman's *Department Notes on Seamanship* (U. S. Naval Institute, \$1.00) contains valuable supplementary matter. Such work might extend to ninety hours. For more extensive instruction Knight's *Seamanship* is the standard text. Since company drill in the army is not essentially different from that in the navy (*Landing Force Manual*, U. S. Navy, 1918, \$1.00) it may be substituted when no naval drill is possible. Swimming and naval calisthenics are possible substitutes for the regular gymnasium work.

**A Specific Instance.** As a specific instance of what is being done, the courses to be given to the Brown Naval Unit during 1918-19 may be cited. An elementary year course in Seamanship (Naval Science A, B, C) based on Chapman's *Practical Motor Boat Handling* (Motor Boating, New York City, \$1.00) and Knight's *Seamanship* (Van Nostrand, \$3.00) is required for the new men. For those who have had this elementary work, a year course (Naval Science D, E, F) is given including further topics in Seamanship, lectures and problems in Ordnance and Gunnery, and lectures by Rear Admiral Edwards, the Com-

mandant of the Unit, on engineering features. Men in this course will serve as officers in the drills. Material for the drills such as cutters, rifles, machine guns and artillery has been supplied by the government. The time devoted to class work together with the outside preparation and the drills (which are required of all) will in each of these courses exceed ten hours per week and three hours credit will be given toward the degree. All men are required to wear a uniform and if eighteen years of age will in all cases be enrolled in the Naval Reserve. Students thus enrolled will be taken for week-end cruises on naval vessels of various types.

A third course given for the Unit three hours throughout the year is Navigation A, B, C. This is open to those who have taken the freshman course in mathematics and by special permission to others who have had Plane Trigonometry. Bowditch's American Practical Navigator (U. S. Hydrographic Office, 1918, Washington, D. C., \$2.25 +) is the text and the student must have the American Nautical Almanac (Nautical Almanac Office, Naval Observatory, Washington, D. C., 15 c. +) and the Altitude, Azimuth and Line of Position Tables (published by Hydrographic Office No. 200, 60 c. +). The first term's work consists of a study of the instruments involved, Dead Reckoning, Spherical Trigonometry and an introduction to Astronomy. In the second term determination of position at sea by observations on celestial bodies is studied, while in the third the remaining parts of Bowditch are covered and the Kelvin-Aquino method learned.

It is probable that for those men who can remain but one or two terms an abbreviated course in Navigation will be given. In that case only the main topics will be covered and the student will not have the opportunity to acquire the desired accuracy and facility.

All the distinctive text-books used at the Naval Academy and others of a similar character are in a special library open to the student.<sup>1</sup> Through the courtesy of the Yale authorities, men from the Brown Unit were invited to attend the Summer Nautical Training School which was held for the Yale Unit at Madison, Conn. In this school the students were under rigid naval discipline and received theoretical and practical instruction in Navigation, Seamanship, Naval Regulations, and Ordnance and Gunnery during the months of July and August.

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<sup>1</sup> The names of the text-books used at Annapolis are given in the Annual Register U. S. Naval Academy (Government Printing Office, Washington, D. C.) a copy of which may be obtained on application to the Academy. For the Departments of Mathematics (beyond the calculus), Navigation, Seamanship, Ordnance and Gunnery the following are the texts: H. E. Smith's Analytic Mechanics, Alger's Hydromechanics, Smith's Strength of Materials, Bowditch's American Practical Navigator, White's Astronomy, Nautical Almanac, Azimuth Tables, Muir's Navigation and Compass Deviation, Logan's Marine Surveying, Practical Manual of the Compass, Stockton's Manual of International Law, Knight's Seamanship, The Deck and Boat Book, Signal Book U. S. Navy, Forms Procedure U. S. Navy, U. S. Naval Regulations, Grant's School of the Ship, Alger's Exterior Ballistics, Curtin and Johnson's Naval Ordnance 1915, Range and Ballistic Tables 1915, Gunnery Instructions 1913, Bureau of Ordnance Pamphlets, Official Publications.

The list of books published for camp libraries by the American Library Association Library War Service (Washington, D. C.) contains many titles in navigation and naval engineering, but it is not discriminating.

**MATHEMATICAL INSTRUCTION AT THE GREAT LAKES NAVAL STATION.**

By I. A. BARNETT, Washington University, St. Louis.<sup>1</sup>

The work in mathematics at the Great Lakes Naval Station is at present under the auspices of the Y. M. C. A. as one of the phases of the Association's general educational program. Among the 40,000 enlisted men there were, at the time the writer left the station (August 15, 1918), about 800 studying mathematics. Their previous training ranged from a grammar-school to a college education. Attendance in the Y. M. C. A. classes was entirely voluntary. About half of those who attended were preparing themselves for the competitive entrance examinations of the Ensign School with a view, after four months' stay in this school, to an Ensign's commission. The subjects of examination are Geography, English, American history (with special emphasis on naval history), arithmetic, algebra (through quadratics), plane geometry and plane trigonometry. The remaining half consisted of men in the aviation school who wanted to learn some mathematics as an aid in their required studies, and to a smaller extent, of those who desired chiefly to advance their education.

There are now about 35 Y. M. C. A. classes in arithmetic, algebra and trigonometry. The topics discussed are as follows. Arithmetic (chiefly review, 6 hours including outside preparation): multiplication, division, g.c.d., l.c.m., fractions, decimals, mensuration, foreign money. Algebra (partly review, 15-20 hours): general nature, fundamental operations, linear equations and applications to problems, factoring, fractions, simultaneous linear equations, extraction of square roots. Trigonometry (mainly new, 10-12 hours): the right triangle and applications, logarithms, the general angle; no proofs. Outlines of these courses were mimeographed and distributed.

There are numerous difficulties in connection with the work. The teachers must be selected from the enlisted men, are usually inexperienced, and are not provided with extra time for the preparation of lessons. The classes are heterogeneous. No special rooms are provided for instruction, which is given in the barracks, the Y. M. C. A. huts or the regimental headquarters, the men often sitting on the floor. Usually there is no time for study except between 6:30 P.M. and 8:00 P.M., and almost all the work must be concentrated during these hours. The men work hard during the day, and only those especially ambitious and energetic attend the classes.

The most obvious and effective way of overcoming these difficulties would be to secure official recognition, by the naval authorities, of the Y. M. C. A. instruction. The writer has been recently informed that a start in this direction has already been made.

**THE NAVAL UNIT AT THE UNIVERSITY OF CALIFORNIA.**

For the proposed naval unit at the University of California,<sup>2</sup> the following outline of courses preparatory for naval service has been provisionally made.

<sup>1</sup> [Dr. Barnett was engaged for a period of 7 weeks in the organization and supervision of the work here described. EDITORS.]

<sup>2</sup> We are indebted to Prof. T. M. Putnam for the information about the war courses at the University of California.

(a) *For Deck Officer*: Plane and Spherical Trigonometry and Elementary Theory of Map Construction, Introduction to Plane and Solid Analytic Geometry, Navigation and Nautical Astronomy, Naval History, Oceanography and Marine Meteorology, Seamanship, Naval Regulations, and Physical Education. With the exception of Physical Education, each course is given 3 hours weekly,  $\frac{1}{2}$  year. There are also drills and practical work at sea, arranged with the coöperation of naval officers. (b) *For Engineer Officer*: As set forth under Course of Instruction on pp. 277-281 of the Annual Register of the U. S. Naval Academy, Annapolis (1917-18), and in addition, Naval Architecture and Marine Engineering. Only such work of the Annapolis curriculum can not be provided for as requires the actual use of Navy equipment not available to the University. This work might be arranged, however, in coöperation with the Commandant of the Twelfth Naval District.

The course in Navigation and Nautical Astronomy, which has been planned to conform as closely as possible to the standards, methods, and general procedure employed by the U. S. Navy, includes the following topics: time and the chronometer; the sextant and its adjustments; the compass (variation, deviation, Napier's diagram, various methods of swinging a ship for deviation, etc.); piloting; the sailings; latitude by meridian altitude, by Polaris, and by circum-meridian altitudes; longitude and time sights; azimuth and amplitude by tables and by computation; the New Navigation (Sumner line, method of St. Hilaire); full day's work at sea. Bowditch's American Practical Navigator, and additionally, the American Nautical Almanac, azimuth tables, tide tables, charts, etc., are used. Sextants, a liquid compass, and other apparatus are available for the practical aspects of the work.

In the Seamanship course, Knight's Seamanship, the Blue Jackets Manual and the Seamanship Department Notes of the U. S. Naval Academy are used. In the course on Naval History, the text-books formerly used by the U. S. Naval Academy were: (1) Short History of the U. S. Navy, by Clark, Stevens, Alden and Krafft; (2) Famous Sea Fights from Salamis to Tsushima by John R. Hale and (3) World Politics at the End of the Nineteenth Century by Paul S. Reinsch. Next term, Naval Powers in the Present War by Gill, Charles and Daran (1917) will be substituted for (3). Besides, the instructors frequently refer to such authors as Mahan, Corbett, etc.

To assist the U. S. Naval Reserve Force in preparing men to pass the examination for the ensign's commission, The University of California has been conducting, since September, 1917, extension courses in (a) Navigation and Nautical Astronomy, (b) Seamanship and Ordnance and (c) Naval Regulations. The equivalent of a high-school education has been a prerequisite; course (a) presupposes Trigonometry. A rough approximation of the total enrollment is 800.

#### NOTES.

At the request of the Commanding Officer of the United States Naval Auxiliary Reserve School at the Chicago Municipal Pier, the Department of Mathematics of the University of Chicago has during the summer conducted